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Introducing case-based peer-assisted learning in a professional course

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Keywords

case-based learning, peer assessment, peer-assisted learning, peer teaching, undergraduate radiography



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Introduction

This paper describes an innovation in the Bachelor of Radiography and Medical Imaging course at an Australian university. The four-year vocational course consists of 30 core units of study, successful completion of which qualifies graduates to practise as radiographers. Four units focus on radiologic biology, where the disciplines of anatomy, physiology, pathology and pharmacology are taught alongside the relevant imaging techniques employed in the clinic to make a diagnosis. Radiologic Biology 3 occurs in the first semester of the second year of the course and covers the systems of the body. In this unit, peer-assisted learning (PAL) is used in conjunction with case-based learning (CBL) to integrate the theoretical content of the multiple disciplines contributing to the unit.

Conceptual Background

The following concepts related to peer teaching, learning and assessment and case-based learning informed the development of the PAL/CBL program.

Peer Teaching and Learning in Higher Education

The idea that knowledge is constructed via social discourse is integral to the process of peers learning from each other. The concept of a zone of proximal development (Vygotsky 1978) suggests that social interaction facilitates learning. Discussion with each other provides students with opportunities to test their ideas, assimilate the ideas of others and build a deeper understanding of what they are learning (Corden 2001; Weber et al. 2008). Topping (2005, p. 631) defines peer learning as “the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions...[which] involves people from similar social groupings who are not professional teachers helping each other to learn and learning themselves by so doing”.

The benefits of peer learning include enhancing cognitive development, motivation and confidence (Hammond et al. 2010; Kibble 2009; McLuckie & Topping 2004; Ten Cate & Durning 2007; Topping 2005). Benefits come from questioning, answering, discussing, clarifying, giving examples and giving and receiving feedback (Khaw et al. 2011; Topping & Ehly 1998). Peer-assisted learning (PAL) may involve higher-level students supporting first-year or lower level students (Kam et al. 2010; Longfellow et al. 2008) or same level peers. Ladyshevsky and Gardner (2008) studied same-level, final-year physiotherapy students undertaking clinical placements, and found that PAL used in conjunction with blogging had a positive effect on participants' reflective practice, heightening their learning and integrating theory into practice. McLuckie and Topping (2004) compared same-level, face-to-face peer tutoring to online peer tutoring and found that merely providing a means for interaction was insufficient, and that tools for supporting and scaffolding the teaching aspect of PAL were required.

Topping (2005) lists training of staff and students as one of 12 points to be considered for a successful PAL program. Although studies of near-level peers have documented various forms of training for peer tutors, few studies have reported this for same-level peers. Tariq (2005) implemented a training schedule for same-level peer tutors in a large class of first-year bioscience students and found that the peer tutors valued the training, gaining confidence that contributed to the success of that PAL program.

Peer Assessment

Assessment practices have a powerful effect on student learning and should be aligned with teaching and learning approaches (Biggs & Tang 2007). Boud, Cohen and Sampson (1999) suggested that assessment of peer learning in authentic ways enhances the success of the approach in terms of students' acceptance and learning. In contrast, the use of individual assessment in conjunction with peer learning and group work can create competition between group members and undermine the benefits of peer learning (Kommallage & Imbulgoda 2010).

Peer assessment "requires students to provide feedback or grades (or both) to their peers on a product or a performance" (Falchikov 2007, p132). It contributes to learning for both assessor and assessed (Boud, Cohen & Sampson 1999). In a formative mode, peer assessment has value through students learning together (Falchikov 2005; Gurkas et al. 2008; Khaw et al. 2011), which contributes to a range of learning skills (such as critical reflection and providing, acting on and integrating feedback), while summative peer assessment involves additional skills relating to the measurement of achievement (Bloxham & West 2004). Peer assessment of an individual's contribution to group work has been shown to encourage student participation provided the method of peer assessment is fair and the students' submissions are confidential (Kench et al. 2009). This approach can be used for summative assessment of group work (Falchikov 2007).

Peer assessment is an important factor in engaging students with learning (Taras 2010). It has been shown to be beneficial to students' learning in the workplace (Falchikov 2007) and to their development as professionals (Vu & Dall'Alba 2007). Peer assessment helps prepare students for the socially constructed and highly situated nature of learning in work and life settings (Boud & Falchikov 2006), which, in the health professional field, frequently involves working collaboratively with others.

Case-based Learning

Case-based learning (CBL), as a form of situated cognition (Brown, Collins & Duguid 1989), is an effective means of combining both activity and context in learning because it requires the learner to apply knowledge to an "authentic" (real-world) task, offering similar benefits to problem-based learning (Boud & Feletti 1997; Williams 2009). Students, in discussing and applying theoretical content to practice, learn more deeply and have opportunities to clarify misunderstandings. A common feature of CBL in health professional education is the alignment of theoretical learning in the formal university setting with that experienced by students in their clinical placements. CBL has been used by health educators to teach clinical reasoning skills to nursing students (Thomas et al. 2001), encourage medical students to develop independent learning skills and a deeper understanding of specific topics (Peplow 1996, 1998) and facilitate inter-professional learning (Curran et al. 2008). Mattick and Knight (2009) used cases to integrate multiple disciplines and provide a vocational aspect to learning. They found that students' approaches to study were influenced by the perceived relevance of the learning task to the real world of a medical practitioner.

The Program

Integrating PAL and CBL

The PAL program was introduced for a series of weekly case studies in the radiologic biology unit. Each student worked in a small, self-selected group of four to five students (small PAL group) to research their patient case, and plan and offer an interactive tutorial for the class (large PAL group). There were six phases of the PAL/CBL program (Figure 1). The activities in each phase are outlined below.

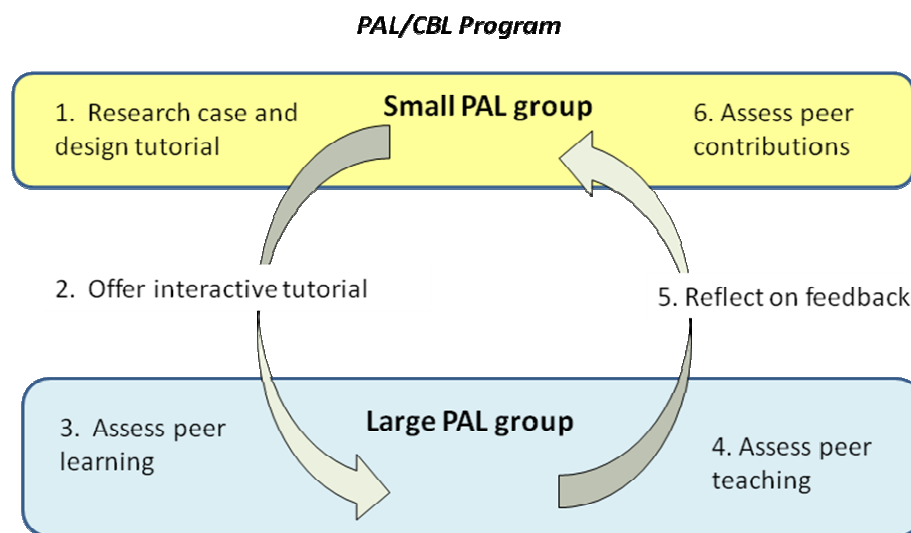


Figure 1: PAL program for the case-study tutorials in radiologic biology

1. Research case and design tutorial: Students in their small PAL group researched their selected case study and designed an interactive tutorial for their peers in the large PAL group.

2. Offer interactive tutorial: The small PAL group offered a 30-minute interactive tutorial to the large PAL group.

3. Assess peer learning: As part of the tutorial, the small PAL group assessed the learning of their peers in the large PAL group using formative-assessment items they had designed.

4. Assess peer teaching: Students in the large PAL group provided anonymous peer feedback to the small PAL group about the case tutorial via a paper-based feedback form designed and collected by staff. Students used a four-point scale to answer questions about the presentation of the case. The marks contributed a minor component (2.5%) to the summative assessment of the PAL/CBL program (15% of overall unit mark). Students were also asked to write comments on what they liked about the tutorial and how it could be improved.

5. Reflect on feedback: The completed feedback forms were given to the small PAL group members during a debriefing session with a staff member.

6. Assess peer contributions: The small PAL group used the information from the assessment of peer learning and the peer assessment of teaching to write a short (two-page) reflective group report about their tutorial. Students in the group submitted a confidential assessment of the small PAL group work in which they rated the contributions and the professionalism of their peers in undertaking the research, preparing and offering the case tutorial. This played a minor role in summative assessment.

Cases reflected the theoretical content of the weekly lectures and were sourced by teaching staff from websites of universities, which permitted their use for educational purposes. All cases included an imaging aspect related to the diagnosis or the treatment of the particular disease. They were chosen to provide contexts that reflected how the knowledge would be used in real life, and to support collaborative construction of knowledge relating to the multidisciplinary aspects of the unit. For example, one case focused on deep vein thrombosis (DVT) in a young woman who had previously changed her contraceptive-pill prescription. This case was developed from a real-life incident published in a newspaper (The Scotsman 2004) and involved the integration of the physiology of blood clotting, the pathology of abnormal blood clotting, the anatomy of the cardiovascular system and the imaging techniques used to diagnose DVT. Teaching staff reviewed and modified information on cases to suit the learning objectives.

Supporting Students in the PAL/CBL Program

Students were supported in the PAL/CBL program in three main ways.

Introducing the PAL/CBL program: In a lecture during the first week of the unit students were introduced to pedagogical research relating to PAL, the details of the PAL/CBL program and the assessment arrangements that would be implemented.

Providing teaching support: A two-hour information session provided students with theoretical information and advice about teaching practice. This included information on learning styles, learning objectives, assessment of learning, alignment of assessment with objectives, teaching activities and how to plan a teaching session.

Case briefing: In the week before each scheduled tutorial the small PAL group discussed the case with an academic case leader, along with strategies for the interactive tutorial and the assessment of the learning of peers in the large PAL group.

Aims of the Study

In this paper we consider responses to the following research questions, based on the results of a study approved by the University Human Ethics Committee that was implemented to investigate the effectiveness of the PAL/CBL program:

- What was the students' experience of participation in case-based PAL?
- What were the students' experiences of teaching, learning and assessment in the PAL/CBL program?
- Is integrating CBL and PAL an effective pedagogical approach?
- Is the use of case-based PAL an effective way to prepare students for the workplace?

Method

Quantitative data was collected using a questionnaire based on that of Houston and Lazenbatt (1996), which was administered by an independent administrative staff member at the completion of the PAL/CBL program. Closed-answer items used a five-point Likert scale. Open-ended questions asked students to explain aspects of the program they enjoyed most and least. The questionnaire contained three sections: (1) learning as member of the large PAL group; (2) learning from preparing and teaching the case; and (3) experience of peer assessment. Responses to the questionnaire items were analysed to identify means, standard deviations and percentages (strongly agree plus agree) from the Likert scale. Quantitative data was also collected from the student assessment of peer contributions to the small PAL group work.

Qualitative data was collected from three sources: the open-ended items on the student questionnaire; semi-structured questions that guided the weekly debriefing session; and an end-of-semester focus group. The debriefing sessions and the focus group were facilitated by academic staff members who were not involved with teaching in the unit.

Questions guiding the weekly debriefing sessions were:

1. What did you learn as part of a group in preparing and offering the tutorial?
2. What did you learn from teaching your peers?
3. What did you learn from assessing your peers?
4. What did you learn from the feedback provided by your peers?
5. Which aspect of the PAL/CBL program contributed most to your learning?
6. Was there anything else that you learned from the PAL/CBL program?

The focus group was held during the last week of semester. It was framed by prompts on the student role as a teacher (in preparing and offering the tutorial), as a learner (participating in and reflecting on the tutorial) and as a participant in a group. Participants were asked how they experienced the program in their small-group and large-group roles.

Qualitative data from these sources were thematically analysed following the five phases described by Braun and Clarke (2006). Each of the data sets was initially transcribed and examined by one author (phase 1) who systematically coded response patterns, collating data relevant to each code and organising data into meaningful groups (phase 2). The analysis was theory-driven, with data sets constructed by mapping codes broadly to aspects of PAL and CBL addressed in the debriefing and focus-group sessions. Data sets were examined by the two other authors, and coding challenged and refined. Coded data was collated into potential themes and sub-themes and all data was compiled per theme using tables (phase 3). Each author checked the relevance of themes in relation to the coded extracts and the entire data set, and a thematic map was generated (phase 4). The specific themes, their definitions and names and their relation to the research questions were refined in an iterative process of review by all authors. Extracts from the data were then selected, relating them back to the analysis of the research questions and literature (phase 5). Rigour was addressed through the iterative nature of analysis and review.

Results

Questionnaire – Quantitative Results

Forty-seven of the 57 enrolled students (82.4%) completed the questionnaire. Responses to learning as a member of the large PAL group are shown in Table 1. The majority of students found the PAL cases enjoyable (91.5%), interesting (100.0%) and relevant (80.9%), and felt that peer learning was a valuable experience (70.2%), with the cases reinforcing their own learning (70.2%). Students were less positive about their peers' teaching when thinking about how much they had learned from the tutorial (Item 10, mean 3.49), and were ambivalent about whether their peers' tutorials motivated them to learn more (51.1%) and helped them become more capable students (51.1%).

Table 1: Learning from the PAL case study tutorials – being a member of the large PAL group

Item*		mean	SD	% agree
1	I found the PAL case study tutorials enjoyable.	4.23	0.60	91.5%
2	I found peer learning a valuable experience.	3.83	0.70	70.2%
3	The case studies were interesting.	4.13	0.34	100.0%
4	The case studies were relevant.	3.98	0.68	80.9%
5	The case studies reinforced my own learning.	3.83	0.76	70.2%
6	The case studies motivated me to learn more about the disease.	3.51	0.93	51.1%
9	I feel that I am a more capable student having gone through this program of peer assisted learning.	3.53	0.80	51.1%
10	On a scale of 1-5, how much did you learn from your peers case study tutorials (5 learned a lot, 1 learned nothing)?	3.49	0.78	N/A

**Items 7 and 8 are excluded from this table because they were open-ended.*

Responses to learning as a member of the small PAL group (Table 2) revealed that most students found it easy to work collaboratively (76.6%), and felt strongly that being able to choose their group enabled them to work well as part of the team (78.3%). They rated highly their peers' ability to meet their learning needs (Item 18, mean 4.04) and their learning from peers (Item 20, mean 4.06). When learning in the small PAL group, most students felt that they were developing higher-order cognitive skills (89.4% and 93.5%) and were able to complete complex tasks (95.7%), learning more broadly than if they had worked on their own (70.2%). Most students (91.5%) stated that they gained a deeper understanding of the case from teaching their peers. Sixty-six percent of students stated that they enjoyed teaching their peers. Fewer students agreed that in researching their topic they drew on their prior learning (57.4%) or wanted to learn more about the topic (57.4%), and only 42.6 percent agreed that their communication skills improved as a result of participation in the case-study tutorial.

Table 2: Learning from the PAL case study tutorials – learning in the small PAL group

Item*		mean	SD	% agree
14	I found it easy to work collaboratively in my small PAL group.	4.06	0.84	76.6%
15	Choosing my small PAL group enabled me to work well as part of a team.	4.06	1.09	78.3%
18	On a scale of 1-5, my small PAL group's ability to meet my individual learning needs was: (5 = excellent, 1 = poor).	4.04	0.81	N/A
20	On a scale of 1-5, how much did you learn from the other members in your small PAL group (5 = learnt a great deal, 1 = learnt nothing)?	4.06	0.76	N/A
21	I enjoyed teaching my peers.	3.81	0.74	66.0%
22	I gained a deeper understanding of the case because I had to teach it to my peers.	4.36	0.64	91.5%
23	In researching the material for the case study tutorial, I drew on my prior learning and experience in the radiography course.	3.66	0.96	57.4%
24	I found myself wanting to learn more about the topic I researched.	3.70	0.81	57.4%
25	I made judgments regarding the validity of the information I used.	4.17	0.60	89.4%
26	Preparation of the case-study tutorial required me to use/develop interpretive skills.	4.04	0.83	93.5%
27	When I was working in my small PAL group, I appreciated the benefits of teamwork to carry out complex tasks.	4.38	0.57	95.7%
28	When I was working in my small PAL group, I learnt more broadly about my topic area than if I had simply studied on my own.	4.02	0.90	70.2%
29	I used a range of resources to research my case-study tutorial, including textbooks, journal articles, web-sites, human resources, television, radio and others.	4.21	0.88	83.0%
30	As a result of my participation in the case study tutorial, my communication skills improved.	2.98	1.17	42.6%

Table 3 shows the student experience of peer assessment of teaching. Seventy-six percent of students felt a greater sense of involvement and responsibility, and 83 percent reported that they listened more attentively during their peers' case-study tutorials because they were performing peer assessment. Knowing that their peers would be assessing their tutorials made students more conscientious in contributing to the group when preparing and offering the case tutorial (78.7%). Seventy percent of students thought that undertaking peer assessment was valuable, but fewer enjoyed completing the peer-assessment task (59.6%).

Table 3: Student experience of peer assessment of teaching

Item		mean	SD	% agree
31	As a result of performing peer assessment of the case-study tutorials, I felt a greater sense of involvement and responsibility.	3.94	0.70	76.6%
32	In performing peer assessment I listened more attentively to my peer's case-study tutorials.	4.06	0.70	83.0%
33	Knowing that my peers would be assessing my group's case-study tutorial made me more conscientious in contributing to the group.	4.06	0.76	78.7%
34	I think performing peer assessment of the case-study tutorials was valuable.	3.79	0.78	70.2%
35	I enjoyed performing peer assessment of the case-study tutorials.	3.64	0.92	59.6%

Questionnaire – Open-ended Items

There were 44 responses to the open-ended questions on the questionnaire describing the best aspects of the PAL program. These indicated that the most enjoyable aspects were watching the creativeness of peers' presentations, working with peers and participating interactively in the tutorials. Of 41 comments listing the least enjoyable aspects of the PAL program, the short time frame available to perform the tasks was the main concern. Other concerns included the amount of information covered by the case tutorials, confusion about the objectives of the PAL program, lack of confidence in teaching, how to assess their peers and requirements for the group written report.

Assessment of Peer-group Contributions – Quantitative Results

Students in seven of the 12 small PAL groups used the assessment of peer contributions to distinguish between group-member contributions, but the difference in marks in each of these groups was no more than three (in a total of 20), indicating that the group-member contributions were relatively even. Students in the remaining five small PAL groups all gave each other the same marks for contributions.

Debriefing and Focus-group Results

Fifty-six students (98.2%) attended the weekly debriefing sessions, which focused on what students were learning from aspects of the PAL process. All of those invited participated in the focus group (12 students, one from each small PAL group). The students' overwhelming response to the program was positive, with the main themes emerging relating to the a number of distinct aspects.

Themes related to working in groups

Students in the debriefing sessions referred to learning that resulted from dividing up roles and tasks as they prepared for and offered the tutorial; helping each other and sharing tasks, compared to working on their own ("Best work is done all together because we could bounce off each other and all contribute what we knew"); and communication in facilitating teamwork ("The group work was easier because we're all friends and we didn't have to get to know each other to work together"). Students identified working in groups as contributing most to their learning, ("I learnt more about myself and how I work as part of a team").

Students in the focus group also stated that a significant value of the PAL program stemmed from working in small groups, and from their need to understand the case and the science behind it in order to explain it to others. They described having to “work out a way to explain it to your peers”, going on to say “some of your material would not match their material and that would force you to go back and research again so that all your research can be put together”. They refined their research, working together to agree on the content of the case and on how to facilitate the learning of their peers in the large class.

Focus-group data revealed that group dynamics varied, with some groups functioning well and others experiencing some dysfunction. Opinions on group selection also varied. Students recognised that group work reflected important aspects of the “real-life” work environment, not all of which were available when groups were self-selected; one student noted that “out in the real world you don’t work in groups with your friends, you work with people you don’t like, people who have different personalities, and you have to get used to it all”.

Themes related to teaching peers: Students in the debriefing sessions referred to learning that resulted from preparing to teach, including researching the case in sufficient detail to be able to present it simply and logically to their peers (“Preparing yourself to present to your peers really consolidates your learning”; “Teaching helps learning. It is different from learning for yourself – you know it better”); trying to make the tutorial interesting, using strategies such as role plays and games; and determining whether peers were interested and engaged (“It was hard to tell if they were interested – they weren’t looking at us, which we found distracting. But when they answered questions they really thought about it – they really tried”). Some groups noted that they now had a different attitude to teaching and to lecturers from the experience of teaching their peers (“Next time...we will have a completely different perspective on how they’re teaching it because we’ve been though it now and can see the difficulties or what can go wrong and what can go well”). As a result, students perceived the value of learning from their peers (“We were interested to hear what our peers have to say – it’s motivational – you pay respect to their presentations and they to yours”; “[Teaching our peers] showed our hard work reflected in their eyes”).

In the focus group, students stated that they felt positive about “getting up in front” of their peers and teaching. Concerns expressed centred on the degree to which they were communicating, conveying the subject material they had prepared and engaging the learners. They recognised that in teaching they had to know the science beyond the presentation to manage the interaction with the learners: “You’re supposed to know the answer as the teacher, and if someone asks you a question and you don’t know the answer, well, what’s the point, really?”

Themes related to assessing peers’ learning: There were varied responses in the debriefing sessions as to what students learned from assessing their peers, though the main focus was on the design of assessment questions. Issues included the need to make the questions challenging to address the main concepts of the case: “We tried answering each other’s questions, which gave us a better idea of what was difficult and what was easy and what was a realistic test of knowledge.”

In the focus group, students stated that they valued the learning activities introduced by their peers. There was agreement that the tutorials evoked a high level of engagement: “It was good because we all speak same language, lecturers they are sometimes so into their own world that they forget who they are teaching to”; “We respect what they [peers] do, and we would expect the same in return for our presentation.”

Themes related to peer feedback on teaching: No dominant themes emerged from the debriefing sessions. Minor themes that emerged included the need to slow the pace and reduce the transmission of information in order to teach effectively (“Students can’t take in everything at once. As a teacher you have to pace it”) and the value of role playing and games to keep students engaged (“The role play kept them interested – almost everyone liked it. Otherwise it just would have been a big chunk of information being served up”). Five groups referred to the value of gaining feedback from their peers: “Getting feedback gives us an understanding of our progress.”

In assessing their peers’ tutorials, students in the focus group stated that they respected their peers, recognising the effort that the small groups had made (“I think we have a lot more respect for our peers [than for our teachers], and so I think we probably afford[ed] them more attention, knowing that we ourselves had to present...”). Some students were reluctant to be critical in their feedback on the tutorials, but the above comment that “we respect what they [peers] do, and we would expect the same in return for our presentation” suggested that the opportunity to give feedback was valued.

Discussion

This study of a group of second-year radiography students provides evidence that the integration of PAL and CBL can promote a positive student experience, offering an effective pedagogical approach. We acknowledge that the use of positive statements in the questionnaire may have had an impact on the results by suggesting agreement (for example, “I found the PAL case-study tutorials enjoyable”). While many students did not agree with some of these statements, the design of questionnaire would have been improved if it had contained a mixture of positively and negatively phrased items. The benefits of PAL (Topping 2005) and CBL (Curran et al. 2008; Williams 2009) for student engagement and learning have previously been reported, but the integration of the two offers additional benefits, particularly in relation to preparing students for the workplace. In this section we consider the findings as they relate to the research questions identified earlier.

What was the students’ experience of participation in case-based PAL?

Students’ acknowledgement of their enjoyment of the PAL/CBL program (and their perception of it as interesting and relevant, offering valuable learning and teaching opportunities) suggested that their experience of participation in case-base PAL was very positive. This was reinforced by responses that indicated that the PAL sessions were the highlight of the week, that students were positive about teaching their peers and that they enjoyed watching the creativity of peers and were highly engaged during their peers’ tutorials. A particularly positive aspect of the experience of participation arose from working in groups, as indicated by the debriefing and focus-group responses, with students appreciating the ability to share tasks, as it enabled them to manage the complexity of the case tutorial and to achieve more than if they had worked on their own (Peplow 1996, 1998; Williams 2009). Tariq (2005) described peer learning benefits in terms of informality with greater freedom to ask questions and less pressure to answer questions correctly. Our study showed that students also valued the creativity of their peers with opportunities to learn in different ways compared to lecturer-led sessions. However, some aspects of the experience were less positive. For example, some students expressed reservations about the short time frame (one week) for preparation and ‘information overload’. The short time frame for the PAL/CBL tutorial preparation resulted from timetabling restrictions and is a factor which would need to be considered by staff who are thinking of implementing a PAL/CBL program. Despite these

reservations, students' responses indicated the value of case-based PAL, with participation in the small groups and teaching their peers providing the most positive experiences in the program.

What were the students' experiences of teaching, learning and assessment in the PAL/CBL program?

Students recognised that “teaching helps learning”, and that, as teachers, they needed to engage their peers in learning. They valued the experience of being taught by their peers. Because they all spoke the “same language”, students felt they could effectively teach and learn together, noting that the respect they had for their peers had a beneficial effect on both the teaching and learning aspects of the PAL/CBL program (Khaw et al. 2011; Topping & Ehly 1998). The case on which students based their tutorial gave them an authentic context for their small-group work, in researching and preparing for their tutorial and in teaching their peers, and helped engage students in the large group by providing a clinical application that showed “how it occurs in real life” (Kibble 2009; Mattick & Knight 2009).

Although many students were positive about their experience of learning in the case-study tutorials, questionnaire scores on how much students had learned from their peers showed only moderate results. Kibble (2009), using supplemental instruction in a PAL program, also found a moderate increase in student learning (increase of one median point on a five-point Likert scale). In contrast, students highly valued their small groups for cognitive development and completing complex tasks, supporting the findings of Ladyshevsky and Gardner (2008). Questionnaire responses indicated limitations of the experience in motivating students to learn, becoming more capable students or developing their communication skills. However, there was some ambiguity in these results, as the debriefing and focus-group comments about motivation and communication were more positive. Overall, students' responses suggested that they learned more from teaching and preparing to teach than from learning in the large group.

Peer-assessment practices can motivate and engage students with learning (Taras 2010). The PAL/CBL program incorporated three episodes of peer assessment (assessing teaching, assessing learning and assessing contributions to group work). In general, students valued the experience of assessing the teaching of their peers (in the small group) because it motivated them to engage in the tutorial. However, fewer of them (although still a majority) enjoyed the experience of performing peer assessment. The students in the small groups appreciated the feedback from their peers in the large group, as it affirmed their hard work and their success in teaching, thereby building confidence and giving them feedback on ways to improve (Bloxham & West 2004; Khaw et al. 2011). The peer assessment of contributions to group work did not indicate a problem with unequal contributions (Kench et al. 2009), though the similarity of grades given appears to confirm that students were reluctant to give their peers widely differing grades (Boud & Falchikov 2006; Kommalage & Imbulgoda 2010). The episodes of peer assessment of teaching were valued by students as both givers and receivers of feedback. There is potential for further exploration of peer assessment of both learning and group contributions in a PAL/CBL setting. Nevertheless, the outcomes support the benefits of integrating peer assessment in PAL suggested by others, including developing students' ability to use criteria to assess peers and gaining an awareness of their own achievements, both of which contribute to their development as learners and teachers (Bloxham & West 2004; Khaw et al. 2011).

Is integrating PAL/CBL program an effective pedagogical approach?

There was considerable evidence from all data sources that the combination of PAL and CBL provided an effective pedagogical approach, adding important dimensions to the program that

helped students frame both their research and their teaching. This was indicated by the positive questionnaire responses on the contribution of the cases to learning, particularly through their use in the small PAL groups to prepare for the case-study tutorials. The value of the cases was reinforced by focus-group comments elaborating on their role in framing research. A number of students also valued the scope for creativity that the cases provided, offering opportunities for the use of activities such as role play, games and quizzes as ways to engage their peers. The work undertaken in the small groups, in particular, indicated the value of integrating PAL and CBL as an effective pedagogical approach. Students worked in higher cognitive domains, sourcing, integrating and critiquing information for their case tutorial. They had to learn the content “better” to “work out a way to explain it to their peers”. However, engagement with the tutorial by students in the large PAL group does not necessarily enhance learning, as indicated by the apparent limitations to learning in the large group noted earlier. This is an important area for further research with respect to the pedagogical value of the PAL/CBL program.

Is the use of case-based PAL an effective way of preparing of students for the workplace?

In the context of preparing students for professional work as radiographers, the use of authentic cases to integrate multiple disciplines and then present and discuss the case with peers offered students a number of realistic experiences relevant to their future professional lives (Ladyshevsky & Gardner 2008; Mattick & Knight 2009). Recognition of the value of teamwork was demonstrated in results from all three data sources, though the focus group data provided evidence that students saw that the benefits of working in groups with their friends did not reflect the ‘real world’. Self-selection of small PAL groups resulted in friends working together which reduced the time required for group formation and performance compared to randomly selected groups, and limited their exposure to one of the aspects of working in groups which would help students prepare for the workplace.

Given the socially constructed and highly situated nature of learning in work and life settings (Boud & Falchikov 2006), the PAL/CBL program contributed to the development of generic workplace skills as it encouraged students to demonstrate a sense of responsibility for learning from and working with their peers, and an awareness of the efforts made by their peers (Boud, Cohen & Sampson 1999; Kench et al. 2009). An awareness of fellow workers’ contributions is important in many workplaces for harmonious teamwork. Despite the ambiguous results mentioned earlier relating to students’ opinion of the value of the PAL/CBL program for improving their communication skills, qualitative data suggested that they felt communication was an important aspect. For example, students felt that they had to “work out a way to explain things” to their peers, indicating the need for good communication. These are skills that are vital for a radiographer, who must communicate with the patient and other health workers in health-care settings.

Conclusion

The PAL/CBL program in a radiologic biology unit in the Bachelor of Radiography and Medical Imaging course offered students many benefits and opportunities, particularly through the experience of working in groups and teaching their peers. It was apparent that students working in small groups to research a case and teach their peers felt that they gained considerable knowledge and understanding about the multidisciplinary aspects of radiologic biology. Students’ engagement in the program as members of the large PAL group and their role in giving feedback on the tutorial

contributed to their motivation. However, the extent to which this involvement improved their learning of radiologic biology is less clear. Further development of the role of peer assessment of learning in the program, and exploration of its significance, may shed light on this aspect. Integration of PAL with CBL contributed to the effectiveness of the pedagogy of the program by providing a real-life context for teaching and learning. Students recognised that interacting with peers would be an important aspect of their working lives, and that the program offered them opportunities to prepare for this. Further development and evaluation of this approach with other groups of students in vocational and non-vocational courses would determine the broader pedagogical effectiveness of integrating PAL and CBL.

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